

(19) World Intellectual Property  
Organization  
International Bureau



(43) International Publication Date  
7 October 2004 (07.10.2004)

PCT

(10) International Publication Number  
**WO 2004/085860 A1**

(51) International Patent Classification<sup>7</sup>: **F16B 1/00**,  
21/06, 21/16, B60R 21/16, B64G 1/64

(21) International Application Number:  
PCT/AU2004/000371

(22) International Filing Date: 24 March 2004 (24.03.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:  
2003901352 24 March 2003 (24.03.2003) AU  
2003905644 15 October 2003 (15.10.2003) AU

(71) Applicant (for all designated States except US):  
**TELEZYGOLOGY INC.** [AU/AU]; Suite 1101, 61  
Lavender Street, Milsons Point, NSW 2061 (AU).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **RUDDUCK**,  
Dickory [AU/AU]; 81 Castle Circuit, Seaforth, NSW

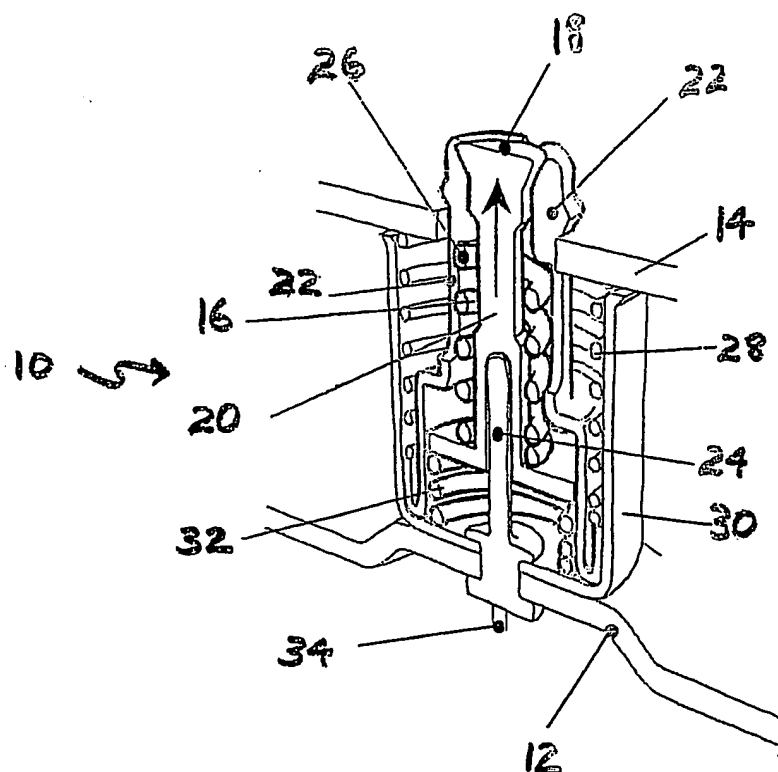
2092 (AU). **HORT, Michael, John, Laybourne**  
[AU/AU]; 3 Sylvia Street, Chatswood, NSW 2067  
(AU). **MCARTHUR, Adam, Russell** [AU/AU]; 3/63  
Lenton Parade, Waterloo, NSW 2017 (AU). **NG, Nicholas,**  
**Anthony** [AU/AU]; South Tower 103, 233 Harris Street,  
Pyrmont, NSW 2009 (AU). **SIZER, Geoffrey, David**  
[AU/AU]; Unit 5, 33 Ryde Road, Pymble, NSW 2073  
(AU).

(74) Agents: **CHRYSILIOU, Kerry et al.**; Chrysiliou Law,  
Level 2, 15-19 Parraween Street, Cremorne, Sydney, NSW  
2090 (AU).

(81) Designated States (unless otherwise indicated, for every  
kind of national protection available): AE, AG, AL, AM,  
AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN,  
CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, ES, FI,  
GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE,  
KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD,  
MG, MK, MN, MW, MX, MZ, NA, NI, NO, NZ, OM, PG,  
PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM,  
TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM,  
ZW.

[Continued on next page]

(54) Title: FASTENER FOR AIR BAGS AND OTHER USES



(57) Abstract: The invention provides a fastener (10) for releasably securing a first element, such as an air bag (12) to a second element such as a bracket (14) located in a vehicle. Fastener (10) has a locking pin (16) which is movable between a locked position and a release position. Locking pin (16) has an engageable head (18). Fastener (10) includes means such as clip (22) for engaging head (18). Locking pin (16) is biased to the release position, for example, by spring (26). Fastener (10) includes an actuator such as spring (32), comprising or including shape memory alloy and adapted to elongate upon application of appropriate energy. When spring (32) is elongated, it causes locking pin (16) to move to the release position. The invention also provides a fastener assembly (130) including at least one post (122) having a groove (124). Fastener assembly (130) includes a bar or latch, for example, in the form of wire (126) adapted to engage the groove (124). Attached to bar (126) is connecting

means, such as shape memory spring (128). Upon application of suitable energy, spring (128) is adapted to change shape and draw bar (126) out of engagement with groove (124).



(84) Designated States (unless otherwise indicated, for every kind of regional protection available): ARIPO (BW, GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

Published:

— with international search report

124 PRTS

10/550814

JC09 Rec'd PCT/PTO 23 SEP 2009

**FASTENER FOR AIR BAGS AND OTHER USES****TECHNICAL FIELD**

This invention concerns fasteners, especially fasteners for air bags in vehicles.

**BACKGROUND ART**

- 5 Air bags are often fitted to vehicles as a safety measure: an air bag is designed to inflate extremely rapidly, if triggered by a sufficiently serious impact, to cushion and protect an occupant from life-threatening injury.

The vehicle manufacturing industry has been fitting air bags to vehicles for several years. Usually, an air bag fitted on the driver's side of the vehicle is inserted in the  
10 steering wheel. Air bags may also be located elsewhere, for example, in the fascia in front of the front seat passenger, in door panels, in vehicle seats or backrests and in roof panels.

In an effort to prevent tampering with air bags, security screws are normally used to affix air bags and/or their covers in the vehicle. Unfortunately, air bag theft has become  
15 one of the fastest-growing automobile crimes, so it is apparent that security screws are inadequate. Most security screws have six-pointed star-shaped heads and require a special screwdriver to remove them. Once a thief has one of these special screwdrivers, which are available relatively freely, it is a simple task to steal an air bag by disconnecting the vehicle battery and removing up to four screws.

- 20 Air bags are also the targets of insurance fraud. Air bags which have not been deployed in an automobile crash may be removed illegally in the repair shop and replaced with a deployed bag. After inspection by an insurance assessor, the original air bag is replaced, and the insurer is billed for a new air bag. Alternately, an undeployed air bag may be pulled out from beneath its cover, so that it seems to have been deployed, then  
25 replaced after inspection with a black market air bag.

While there is a need for preventing unauthorised access to air bags, there is a continuing requirement to utilise fasteners which permit rapid assembly of the air bag to the vehicle during vehicle construction.

## DISCLOSURE OF THE INVENTION

- 5 It is an object of the present invention to provide an air bag fastener which overcomes or at least alleviates some or all of the described problems. In particular, it is an aim of the invention, at least in some embodiments, to prevent unauthorised access to air bags, while facilitating rapid assembly.

Accordingly, in a first aspect, this invention provides a fastener for releaseably securing  
10 a first element to a second element in a spaced-apart relationship, the fastener including:

- (a) a locking pin movable between a locked position in which the first element is secured in spaced relationship to the second element and a release position in which the first element is released from the second element, the locking pin having an engageable head;
- 15 (b) means for engaging the head of the locking pin with the second element;
- (c) bias means urging the locking pin to the release position; and
- (d) an actuator comprising or including shape memory alloy adapted to elongate upon application of appropriate energy;

wherein the actuator is adapted, when elongated, to cause the locking pin to move to the  
20 release position.

It is preferred that the fastener includes an integrated processor, switch and one or more sensors. The sensors can carry out the function of sensing whether the locking pin is in the locked or release position.

The fastener of the invention is particularly suitable for retaining an air bag or other  
25 automotive component behind a fascia or other cover. In this situation, the first element

may be a base to which the air bag is secured and the second element may be a fascia or cover.

The locking pin may be made of any suitable material but is preferably made of suitable polymeric material. If desired, the locking pin may have an internal cavity adapted to receive a guide pin. This can facilitate assembly of the fastener and help to maintain rigidity in situ.

In the locked position, the engageable head of the locking pin is engaged with the second element (such as a cover). The means for engaging the head of the locking pin with the second element may be of any suitable design. Preferably, the engaging means comprises or includes a clip. Such a clip may be annular, for example and may be in two or more (for example, four) parts. The clip is preferably of elastic material. Preferably, the engageable head of the locking pin engages the engagement means, such as a clip, the engagement holding the assembly in the locked position. Preferably, when the locking pin is moved to the release position, the head of the locking pin is disengaged from the engagement means. This may in turn permit the engagement means to be compressed and the assembly can pass through an aperture in the second element, thus releasing the second element from spaced relationship with the first element. In some embodiments, the fastener is assembled onto the first element.

The bias means urging the locking pin to the release position is preferably a coiled spring. In the release position the locking pin may stand proud of the second element or may retreat below the second element.

The actuator is preferably a single coiled spring made of shape memory alloy. An example of this is sold as Nitinol, an alloy of nickel and titanium. This material has a crystalline transition temperature. When the material is heated past its crystalline transition temperature, it reverts to a memorised configuration. Thus, a coiled spring of Nitinol can be formed in a first configuration, in which the spring is relatively short, and revert to a memorised configuration, in which the spring is elongated, after heating. Heating is preferably provided by cabled connection between the actuator and an energy

source, such as the battery of the vehicle. An external energy source may also be used. Preferably, there is a cable connection between the energy source and the actuator. However, it is within the scope of this invention that the energy is applied remotely, for example by use of an infra red beam or ultrasound.

- 5 It will be appreciated by one skilled in the art that the fastener of this invention may default to the locked position. It is only when energy is applied in a suitable manner that the fastener releases.

In the embodiment described in which the fastener of the invention has an actuator being a single coiled spring, the fastener may be described as "monostable". With this  
10 type of fastener, in the first place the fastener may be assembled to the first and second elements mechanically. Later, when appropriate, the application of suitable energy causes the fastener to release the second element from the first element.

As an alternative, the fastener may be bistable. This will usually require more than one actuator. In this embodiment, the application of suitable energy will release the fastener  
15 from the first and second elements, as set out above. This may involve one of the actuators. The application of suitable energy to another of the actuators may cause the fastener to secure the first and second elements in spaced relationship and to hold the first and second elements in that configuration once the application of energy has ceased.

- 20 In the case of the bistable fastener, as in the case of the monostable fastener, there may be no need to keep a supply of electrical current (or other energy) to the fastener in order to retain it in the locked position. However, if there is no such supply, it may be desirable to include a detent to hold the bistable fastener in the locked and/or released position. For example, the locking pin may include a groove into which a detent can  
25 clip when the fastener is unlocked, the detent providing sufficient interference to prevent the locking pin retreating towards the locked position, unless positively actuated.

The monostable fastener can be designed to release irreversibly, so that once release has taken place, the fastener must be replaced before an air bag can be mounted behind the fascia or cover. This can be useful to give and maintain a ready visual indication of tampering. Alternately, the fastener having a single actuator may be designed so that when the actuator cools, it reverts to the original configuration. The fastener assembly may then be pulled back into the locked position or it may be possible to mechanically assemble the fastener with the first and second elements, to the configuration existing before release.

In prior art fastener assemblies, there are usually two to four fasteners provided for each air bag. The fastener of the present invention may be designed to communicate with one, two or three (or more) "slave" fasteners. Thus, it may be necessary to provide an instruction via the energy source only to the "master" fastener which incorporates appropriate integrated electronics. When this fastener is caused to release, it can at the same time communicate with the other fastener or fasteners, causing them to release also.

The fastener of the invention preferably includes one or more sensors to sense and report on the status of the fastener, namely, whether the locking pin is in the locked or release position. Such a sensor preferably uses micro-switches which can be mechanically activated by the locking pin or an extension of the locking pin, for example.

Especially where the fastener is used to secure an air bag, it may be useful to include in the air bag assembly a sensor capable of sensing and reporting the presence or absence of the air bag. Such a sensor may be similar to that described above in relation to the fastener.

Encryption may be an important tool in preventing unauthorised access to the fastener of the invention. Preferably, each fastener of the invention is provided with an "address" so that a fastener to be released can be selected. Access to the "address" may be encrypted by using a simple or sophisticated key. Each fastener may also include

means for enabling a fastener to "recognise" an authorised operator, requiring "handshake encryption".

Installation of air bags using the fastener of the invention and servicing/release of the air bags is preferably handled via computer communication from a technician to the  
5 vehicle. Most vehicles today include a computer in the form of an engine control unit (ECU) which operates a local interconnect network (LIN) to monitor and report on automobile units and to carry digital instructions to those units. The following embodiment describes installation and release of a fastener of the invention via the ECU. However, it is to be understood that the invention is not limited to this  
10 environment.

Four fasteners according to the invention are connected to a conventional bracket for an air bag and the air bag is attached to the bracket in the normal manner. The fasteners are connected to wiring for the air bag. A technician attaches a laptop to the ECU and checks that the air bag sensor has detected the presence of the air bag. The technician  
15 downloads from the fasteners the encryption and "status" codes, embedded in one of the fasteners, which will enable the air bag to be serviced or reassembled. The "status" codes indicate whether the fasteners are in the locked or release position.

Next, the air bag wiring is connected to the ECU via a conventional connection on the steering wheel. If the fasteners are supplied in the locked configuration, the technician  
20 instructs the fasteners to unlock via a software interface on the laptop. The air bag assembly is placed in the correct position on the steering wheel. Using the laptop, the technician instructs the fasteners to de-power, blind fastening the air bag in place.

The fastener "status" report - showing the fasteners are in the locked position - is updated, as is a history log.

25 At this stage, the air bag has been assembled to the vehicle. Assembly has taken place quickly and without the awkward assembly access frequently encountered in prior art



situations. The air bag assembly does not have any fasteners which can be accessed by traditional means, reducing or eliminating the opportunity for theft of the air bag.

If an air bag is faulty or has been deployed after impact, the vehicle is taken to an authorised repair shop. Here a technician plugs a laptop into the ECU and downloads  
5 the appropriate information, including the status of the fasteners and the status of the air bag (present or absent). Optionally, the dialogue between the fasteners and the laptop recognises the authority of the laptop to operate the fasteners. Within a software interface on the laptop, the technician can instruct the fasteners to release. The ECU sends an electronic message to a controller chip mounted in the air bag or integrated  
10 into one of the fasteners. The controller chip, in turn, supplies the appropriate current from the vehicle's battery to the fastener or fasteners. The current supplies heat to the actuator which elongates and pushes the lock pin out of engagement with the second element. Access is then provided to the air bag.

It is also within the scope of this invention to provide a manual override if the actuator  
15 fails or if an energy source cannot be provided. The air bag assembly may carry on the first or second element an indicator, such as a moulded depression, into which a special tool may be pressed. The tool can pierce the air bag and push the lock pin to the unlocked position. This renders the air bag unusable so it can operate as a tamper evident mechanism.

20 In a second aspect, this invention provides a fastener assembly for releasably securing an element, the element including a post or pin having a groove, the assembly including a bar adapted to engage the groove to secure the element, the assembly also including a connecting means attached to the bar and consisting of or including shape memory material which, upon application of suitable energy, is adapted to change shape and  
25 draw the bar out of engagement with the groove, thus releasing the element.

Preferably, the element has more than one post or pin, each having a groove. The bar may engage the groove in more than one post or pin. In one embodiment, the bar engages the groove in each of two posts or pins. In the case of a fastener assembly for

an air bag, preferably there are four posts and two fastener assemblies, each engaging the groove in two posts.

The post or pin may be chosen from a large range of suitable shapes. As one example, the pin may be generally circular in cross-section, tapering in from a flanged base and  
5 having a further taper in at the end remote from the flanged base. In this example, the pin may include a groove around its circumference. The groove may be adapted to receive one bar or a plurality of bars around the circumference of the groove. In this embodiment, the bar may comprise a latch engaged in the groove when the pin is locked and adapted to be moved out of engagement with the groove, and so unlock the pin, by a  
10 shape memory alloy wire which contracts when heated.

The pin or post may be formed integrally with or attached to the element to be fastened.

The material adapted to contract when activated is preferably shape memory alloy wire, as described in connection with the two embodiments above. Shape memory alloys are known and are usually made predominantly or wholly of titanium and nickel. They may  
15 also include other material, such as aluminium, zinc and copper. A shape memory alloy is capable of adopting one shape below a predetermined transition temperature and changing to a second shape once its temperature exceeds the transition temperature. Conversely, when the shape memory alloy cools below the transition temperature, it is capable of adopting the first shape again. In connection with the second aspect of the  
20 present invention, it is preferred that the shape memory alloy contracts (or straightens, as appropriate) when heated in situ.

The scope of the invention in the second aspect is not necessarily limited to the use of shape memory alloy. Other material may also be useful.

The connecting means is preferably in the form of shape memory wire of the type  
25 already discussed. However, it is particularly preferred that the shape memory material is a titanium-nickel wire which, when sufficient energy in the form of an electrical current is applied, heats to or above the temperature at which the material shrinks by

45%. It is preferred that the connecting means is attached to each end of the bar and, upon shrinking, draws the bar out of engagement with the groove.

The bar may need to be biased into engagement with the groove in the secured position.

The fastening system of this second aspect of the invention may be particularly suitable  
5 for fastening interior panels in automobiles. One example is the fastening of the interior lining of a door panel to the car door.

The invention in its various aspects will now be described in connection with certain non-limiting embodiments shown in the accompanying drawings.

## **BRIEF DESCRIPTION OF THE DRAWINGS**

10 In the drawings:

Figure 1 is a sectional, perspective view of a first embodiment of a fastener according to the first aspect of the invention, showing the locking pin in the locked position;

Figure 2 is a similar view of the fastener of Figure 1, showing the locking pin in the release position;

15 Figure 3 is a perspective view of an air bag module during assembly to a steering wheel, using the fastener of the invention;

Figure 4 is a cross sectional view of a second embodiment of the fastener of the invention;

Figure 5 is a cross sectional view of a further embodiment of the fastener of the first  
20 aspect of the invention, similar to that in Figure 4, but showing the fastener in situ between an air bag molding and a steering wheel casting;

Figure 6 is an exploded view of the assembly of Figure 5;

Figure 7 shows in larger scale and in reverse configuration the portion of Figure 6 marked 7-7;

Figure 8 shows in larger scale and in reverse configuration the portion of Figure 6 marked 8-8;

Figure 9 is a similar view of the area marked 9-9 on Figure 6;

Figure 10 is a substantially enlarged, partly diagrammatic, perspective view from  
5 below of a micro switch assembly connected to override button 110 which is shown in Figure 5;

Figure 11 is a view of the same assembly as that in Figure 10, rotated through around ninety degrees;

Figure 12 is a perspective view of a first embodiment of the fastener assembly of the  
10 invention in its second aspect;

Figure 13 is a perspective view of the fastener assembly of Figure 12 in situ securing two elements, partly in exploded view;

Figure 14 is a perspective view of one of the posts shown in Figure 13;

Figure 15 is a perspective view of an element having four posts as in Figure 14,  
15 Figure 15 being in reduced scale compared to Figures 13 and 14;

Figure 16 is a plan view transparent as to some detail, of a second embodiment of fastener assembly of the invention in its second aspect;

Figure 17 is a side elevation of the embodiment in Figure 16; and

Figure 18 is an end elevation of the embodiment in Figure 16.

## 20 BEST MODES FOR CARRYING OUT THE INVENTION

Referring first to Figures 1 and 2, fastener 10 releasably secures air bag bracket 12 to bracket 14 located on the steering wheel of a vehicle. Fastener 10 has a locking pin 16 which is movable between the locked position shown in Figure 1 and the release position shown in Figure 2. In the locked position shown in Figure 1, bracket 14 is held

in spaced relationship with air bag bracket 12. As can be seen from Figure 2, when locking pin 16 is in the release position, air bag bracket 12 is no longer held in spaced relationship with bracket 14.

Locking pin 16 includes head 18 being of larger dimension than shaft 20 of locking pin 16. In the locked position, head 18 engages clip 22. The engagement between head 18 and clip 22, together with guide pin 24, hold locking pin 16 in the configuration shown in Figure 1.

Locking pin 16 is biased towards guide pin 24 by spring 26. A second spring 28 acts as an ejector when head 18 is released from clip 22. Spring 28 sits within outer sleeve 30.

Spring 32, of shape memory alloy, is the actuator for releasing fastener 10. Actuator spring 32 communicates via ECU cable attachment point 34 with the vehicle's power source (the battery). When energy supplied by the battery (not shown) causes actuator spring 32 to heat above its crystalline transition temperature, spring 32 expands to the configuration shown in Figure 2, bearing on plate 36 and pushing locking pin 16 upwardly against the bias of spring 26. Once head 18 has been pushed above clip 22, clip 22, being made of resilient material, can deflect inwardly and both clip 22 and head 28 are free to be ejected below bracket 14, under the influence of ejector spring 28, to assume the release configuration shown in Figure 2.

The size of cavity 38 in bracket 14 is chosen to prevent release of fastener 10 when head 18 engages clip 22 and to permit both head 18 and clip 22 to pass through when there is no such engagement.

Fastener 10 is shown in situ in Figure 3, attached to air bag bracket 12 on vehicle steering wheel 40. An air bag (not shown) is mounted behind cover 42. The interface between cable attachment port 34 and the vehicle ECU is effected through electronics link 44.

In the configuration shown in Figure 3, fastener 10 is an intelligent fastener which is linked to three slave fasteners to be inserted in apertures 46, 48 and 50. When fastener 10 is actuated, it communicates with the slave fasteners so that they are also released.

Preferably, there is also mounted on air bag bracket 12 one or more sensors to sense whether the air bag is present or absent. The choice of suitable sensor will be apparent to one skilled in the art. The sensor or sensors may be part of cover 42 instead of on air bag bracket 12, as desired.

The embodiment illustrated in Figures 1 and 2 is monostable in that there is a single actuating spring 32 and, when heated, this spring expands or elongates to release the fastener.

The second embodiment illustrated in Figure 4 is a bistable version of the fastener of the invention. In this Figure, fastener 60 once again hold air bag bracket 12 in spaced relationship with steering wheel bracket 14. Locking pin 56 includes head 58 designed to engage with clip 62. In this embodiment, however, there is no guide pin. Instead locking pin 56, has, besides head 58, upper shaft 52 and lower shaft 54. Cavity 64 journaled into and through each of lower shaft 54 and upper shaft 52 and part way into head 58 allows for manual release of fastener 60. Insertion of a thin tool of sufficient length through aperture 66 along the length of cavity 64 and pressure on head 58 can cause head 58 to be popped clear of clip 62, allowing clip 62 to fold in as in the embodiment in Figures 1 and 2.

Like the embodiment in Figures 1 and 2, fastener 60 includes ejector spring 68 within sleeve 70. However, there is no bias spring 26 in fastener 60. Instead, fastener 60 has two shape memory springs 72 and 74. Actuator spring 72 carries out the same role as actuator spring 32 in the case of fastener 10. Actuator spring 74, once actuated through heat when fastener 60 is in the release position, expands to push head 58 into engagement with clip 62 and to secure steering wheel bracket 14 in spaced relationship with air bag bracket 12.

Fastener 60 is shown with clip-on electronics controller 76, which communicates with the vehicle's ECU. Figure 5 is very similar to that Figure 4 and the same numerals are used to indicate the same components.

In Figure 5, clip-on electronic controller 76 is shown on the right hand side of the  
5 Figure rather than on the left as in Figure 4.

The fastener of Figure 5 is that shown in exploded view in Figures 6, 7, 8 and 9. Larger scale views of the areas marked appropriately in Figure 6 are illustrated in Figures 7, 8 and 9. For ease of reference, there is overlap between Figures 7 and 8. It will be noted that the screw shown on the left hand side of Figure 7 is repeated on the right hand side  
10 of Figure 8. It is also to be noted that in Figure 7 some of the components shown have not been "exploded" to the extent illustrated in Figure 6.

In Figure 7, clip 58 is shown mounted on air bag molding 12. Plunger washer 88 is located at the base of shape memory alloy spring 72, assembled around lower shaft 54. Actuator plate 78, when assembled, is sandwiched between washer 84 and washer 86.  
15 Shape memory alloy spring 74 is assembled around upper shaft 52. Washer 80 is inserted between upper shaft 52 and head 58, into which screw 82 is inserted.

Turning now to Figure 8, where screw 82 is repeated to show continuity from Figure 7, one end of ejector spring 68 fits within the wider portion of clip sleeve 90. Also shown in Figure 8 are clip sleeve lock ring 92 and clip sleeve cover 94.

20 Figure 9 shows the components of clip-on electronic controller 76, illustrated in the lower part of Figure 5. It will be seen that the assembly includes mounting boss 96, with bottom cover 98 and top cover 106 enclosing crimps 100 and 102 and leads 104. Override button 110 is received in mounting boss cap 108 and is integral with shaft 112 which is fitted into lower shaft 54 (which, in this embodiment, takes the form of a  
25 sleeve).

Turning now to Figures 10 and 11, micro switch assembly 120 can be integrated with, for example, the assembly shown in Figure 5 in any suitable way. For example,

assembly 120 can be fitted within top cover 106 in Figure 5, with cap 108 being integrated in assembly 120 as shown in Figures 10 and 11.

Assembly 120 includes first micro switch 112 and second micro switch 114, as well as integrated microprocessor 116, for switching via a data bus. In both Figures 10 and 11, 5 override button 110, which is in effect an extension of screw 82 in Figure 5, is shown in the "up" position with reference to Figures 10 and 11. This corresponds with the "down" position in Figure 5. In this position, screw 82 is locked. Micro switch 112 is closed in this position, while micro switch 114 is open.

If screw 82 was in the release position, override button 110 would be "up" with 10 reference to Figure 5 and "down" with reference to Figures 10 and 11. In this configuration, micro switch 112 would be open and micro switch 114 would be closed.

With reference now to the embodiment of the invention in its second aspect in Figures 12 and 13, fastener assembly 130 is intended to releasably secure an element such as air bag 118 (refer Figure 15). Air bag 118 in this embodiment has four posts 122, one of 15 which is shown in larger scale in Figure 14. Post 112 includes groove 124.

Fastener assembly 130 includes a bar, in this embodiment in the form of wire 126, which is biased into engagement with groove 124 in situ. Attached to each end of wire 126 is shape memory spring 128 which is held proud of support 132 by brace 134.

Plastic caps 136 prevents spring 128 from shorting out fastener assembly support 132.

20 Fastener assembly 130 includes apertures 138 to receive posts 122.

As illustrated in Figure 13, fastener assembly 130 can be fixed to removable cap 140. Cable connectors 142 attach to ends 144 of shape memory spring 128, to provide the necessary energy to actuate shape memory spring 128 and cause it to shrink.

As it will be appreciated, when sufficient energy, in the form of heat, is supplied to 25 shape memory spring 128 via cable connectors 142, spring 128 contracts. Since it is braced against brace 134, spring 128, in the contracted form, will draw the ends of wire



126 out of engagement with grooves 124 in posts 122, thus permitting release of air bag 118.

It is advantageous that fastener assembly 130 may be retro-fitted to existing air bag assemblies.

- 5 Turning now to Figures 16 to 18, fastener 210 has a pin 212 adapted to be received in aperture 214. Latch 216 locks pin 212 by entering groove 218. Latch 216 is connected to shape memory alloy wire 220 which passes from anchor point 222 over guide 224 to end 226 of latch 216. When shape memory alloy wire 220 is heated sufficiently, it contracts, drawing on end 226 of latch 216 and hence drawing latch 216 out of  
10 engagement in groove 218, unlocking pin 212.

Pin 212 has first taper 228 and second taper 230. Second taper 230 expands to form flange 232. In Figures 17 and 18 it can be seen that flange 232 is attached to element 234. Pin 212 may of course be integral with element 234.

#### INDUSTRIAL APPLICABILITY

- 15 It will be appreciated that the fasteners of the present invention can be "blind" fixed and therefore may be highly tamper-resistant. It is possible to manufacture the fasteners of the invention at very small cost and they can be easily integrated into existing vehicle electronic systems. The fasteners of the invention can be designed so they provide visual evidence of tampering. It is also possible to provide for manual operation of the  
20 fastener in appropriate circumstances.

As will be readily appreciated by those skilled in the various arts, the inventions disclosed herein are not limited to the example set out and have wide applications in many areas. These inventions represent significant advances in the relevant arts.

## Claims

1. A fastener for releasably securing a first element to a second element in a spaced-apart relationship, the fastener including:

(a) a locking pin moveable between a locked position in which the first element is secured in spaced relationship to the second element and a release position in which the first element is released from the second element, the locking pin having an engageable head;

(b) means for engaging the head of the locking pin with the second element;

(c) bias means urging the locking pin to the release position; and

(d) an actuator comprising or including shape memory alloy adapted to elongate upon application of appropriate energy;

wherein the actuator is adapted, when elongated, to cause the locking pin to move to the release position.

2. The fastener of claim 1, which also includes an integrated processor, a switch and one or more sensors.

3. The fastener of claim 2, in which the sensor is adapted to sense whether the locking pin is in the locked position or the release position.

4. The fastener of claim 3, in which the sensor includes micro switches adapted to be activated by the locking pin or an extension of the locking pin.

5. The fastener of any one of any one of claims 1 to 4, wherein the locking pin is made of polymeric material.

6. The fastener of any one of claims 1 to 5, wherein the locking pin has an internal cavity adapted to receive a guide pin.

7. The fastener of any one of claims 1 to 6, wherein the means for engaging the head of the locking pin with the second element comprises or includes a clip.
8. The fastener of claim 7, wherein the clip is annular.
9. The fastener of claim 7 or 8, wherein the clip is in two or more parts.
- 5 10. The fastener of any one of claims 7 to 9, wherein the clip is made of elastic material.
11. The fastener of any one of claims 1 to 10, wherein the locking pin is adapted to be held in the locked position by engagement of the head of the locking pin by the engagement means.
- 10 12. The fastener of claim 11, wherein the locking pin is adapted to move to the release position after disengagement of the head of the locking pin from the engagement means.
13. The fastener of any one of claims 1 to 12 when assembled onto the first element.
14. The fastener of any one of claims 1 to 13, wherein the bias means urging the  
15 locking pin to the release position is a coiled spring.
15. The fastener of any one of claims 1 to 14, wherein the actuator is a single coiled spring made of shape memory alloy.
16. The fastener of claim 15, wherein the actuator is adapted to elongate by energy provided from an energy source.
- 20 17. The fastener of claim 16, wherein there is a cable connection between the energy source and the actuator.
18. The fastener of claim 16, wherein the energy is in the form of infra red light or ultrasound.

19. The fastener of any one of claims 1 to 18, wherein the locking pin is adapted to default to the locked position.
20. The fastener as claimed in any one of claims 1 to 19, which includes a second actuator.
- 5 21. The fastener of claim 20, wherein the second actuator comprises or includes shape memory alloy adapted to elongate upon application of appropriate energy to cause the locking pin to move to the locked position.
22. The fastener of any one of claims 1 to 21, which includes a detent adapted to hold the locking pin in the locked and/or release position.
- 10 23. The fastener of claim 22, wherein the detent is adapted to clip into a groove in the locking pin when the locking pin is in the release position, the engagement between the detent and the groove being adapted to prevent the locking pin moving towards the locked position without positive actuation.
24. The fastener of any one of claims 1 to 19, wherein the locking pin is adapted to  
15 move from the locked position to the release position irreversibly.
25. The fastener of any one of claims 1 to 19, wherein the actuator is adapted to cause the locking pin to move to the locked position when no longer elongated.
26. The fastener of any one of claims 1 to 25, which also includes means to communicate with at least one slave fastener.
- 20 27. The fastener of claim 26, wherein the communication means is adapted to communicate with the slave fastener when the locking pin has been caused to move to the release position.
28. The fastener of any one of claims 1 to 27, wherein the fastener has an address.
29. The fastener of claim 28, wherein the address is encrypted.

30. The fastener in any one of claims 1 to 29, wherein the fastener includes means for enabling the fastener to recognise an authorised operator.
31. The fastener of any one of claims 1 to 30, wherein the locked pin is adapted to be moved to the release position manually.
- 5 32. A fastener assembly for releasably securing an element, the element including a post or pin having a groove, the assembly including a bar adapted to engage the groove to secure the element, the assembly also including a connecting means attached to the bar and consisting of or including shape memory material which, upon application of suitable energy, is adapted to change shape and draw the bar  
10 out of engagement with the groove, thus releasing the element.
33. The fastener assembly of claim 32, wherein the element has more than one post or pin, each having a groove.
34. The fastener assembly of claim 33, wherein the bar is adapted to engage the groove in more than one post or pin.
- 15 35. The fastener assembly of claim 34, wherein the bar engages the groove in each of two posts or pins.
36. The fastener assembly of any one of claims 32 to 35, wherein the connecting means is a shape memory wire.
- 20 37. The fastener assembly of claim 36, wherein the shape memory wire is a titanium-nickel wire.
38. The fastener assembly of claim 36 or 37, wherein the connecting means is attached to each end of the bar and is adapted to change shape by shrinking to draw the bar out of engagement with the groove.
- 25 39. The fastener assembly of any one of claims 32 to 38, wherein the bar is biased into engagement with the groove.

40. A fastener assembly substantially as herein described with reference to Figures 12 to 15 or 16 to 18 of the accompanying drawings.

41. A fastener for releasably securing an airbag between a base and a cover, the fastener including:

5 (a) a locking pin moveable between a locked position in which the base is secured in spaced relationship to the cover and a release position in which the base is released from the cover, the locking pin having an engageable head;

(b) means for engaging the head of the locking pin with the cover;

10 (c) bias means urging the locking pin to the release position; and

(d) an actuator comprising or including shape memory alloy adapted to elongate upon application of appropriate energy,

wherein the actuator is adapted, when elongated, to cause the locking pin to move to the release position.

15 42. The fastener of claim 41, which also includes an integrated processor, a switch and one or more sensors.

43. The fastener of claim 42, in which the sensor is adapted to sense whether the locking pin is in the locked position or the release position.

44. The fastener of claim 43, in which the sensor includes micro switches adapted to  
20 be activated by the locking pin or an extension of the locking pin.

45. The fastener of claim 41 which also includes a sensor adapted to sense and report the presence or absence of the airbag.

46. The fastener of any one of any one of claims 41 to 45, wherein the locking pin is made of polymeric material.

47. The fastener of any one of claims 41 to 46, wherein the locking pin has an internal cavity adapted to receive a guide pin.
48. The fastener of any one of claims 41 to 47, wherein the means for engaging the head of the locking pin with the cover comprises or includes a clip.
- 5 49. The fastener of claim 48, wherein the clip is annular.
50. The fastener of claim 48 or 49, wherein the clip is in two or more parts.
51. The fastener of any one of claims 48 to 50, wherein the clip is made of elastic material.
52. The fastener of any one of claims 41 to 51, wherein the locking pin is adapted to  
10 be held in the locked position by engagement of the head of the locking pin by the engagement means.
53. The fastener of claim 52, wherein the locking pin is adapted to move to the release position after disengagement of the head of the locking pin from the engagement means.
- 15 54. The fastener of any one of claims 41 to 53 when assembled onto the base.
55. The fastener of any one of claims 41 to 54, wherein the bias means urging the locking pin to the release position is a coiled spring.
56. The fastener of any one of claims 41 to 55, wherein the actuator is a single coiled spring made of shape memory alloy.
- 20 57. The fastener of claim 56, wherein the actuator is adapted to elongate by energy provided from an energy source.
58. The fastener of claim 57, wherein there is a cable connection between the energy source and the actuator.

59. The fastener of claim 57, wherein the energy is in the form of infra red light or ultrasound.
60. The fastener of claim 57, wherein the energy source is a vehicle battery.
61. The fastener of any one of claims 41 to 60, wherein the locking pin is adapted to default to the locked position.
62. The fastener as claimed in any one of claims 41 to 61, which includes a second actuator.
63. The fastener of claim 62, wherein the second actuator comprises or includes shape memory alloy adapted to elongate upon application of appropriate energy to cause the locking pin to move to the locked position.
64. The fastener of any one of claims 41 to 63, which includes a detent adapted to hold the locking pin in the locked and/or release position.
65. The fastener of claim 64, wherein the detent is adapted to clip into a groove in the locking pin when the locking pin is in the release position, the engagement between the detent and the groove being adapted to prevent the locking pin moving towards the locked position without positive actuation.
66. The fastener of any one of claims 41 to 60, wherein the locking pin is adapted to move from the locked position to the release position irreversibly.
67. The fastener of any one of claims 41 to 60, wherein the actuator is adapted to cause the locking pin to move to the locked position when no longer elongated.
68. The fastener of any one of claims 41 to 67, which also includes means to communicate with at least one slave fastener.
69. The fastener of claim 68, wherein the communication means is adapted to communicate with the slave fastener when the locking pin has been caused to move to the release position.



70. The fastener of any one of claims 41 to 69, wherein the fastener has an address.

71. The fastener of claim 70, wherein the address is encrypted.

72. The fastener of any one of claims 41 to 71, wherein the fastener includes means for enabling the fastener to recognise an authorised operator.

5 73. The fastener of any one of claims 41 to 72, wherein the locked pin is adapted to be moved to the release position manually.

74. A fastener substantially as herein described with reference to Figures 1 to 3 or 4 or 5 to 9 or 10 to 11 of the accompanying drawings.

10 75. A method of installing an airbag between a base and a cover, the method including the steps of:

(a) connecting at least one fastener as claimed in any one of claims 41 to 74 to the base;

(b) connecting the airbag to the base; and

15 (c) causing the locking pin to move to the locked position to secure the airbag between the base and the cover.

76. The method of claim 75 in which steps (a) and (b) are reversed.

77. The method of claim 75 or 76, which includes the further step of connecting each fastener to wiring for the airbag.

20 78. The method of claim 77, wherein the airbag wiring is connected to an engine control unit.

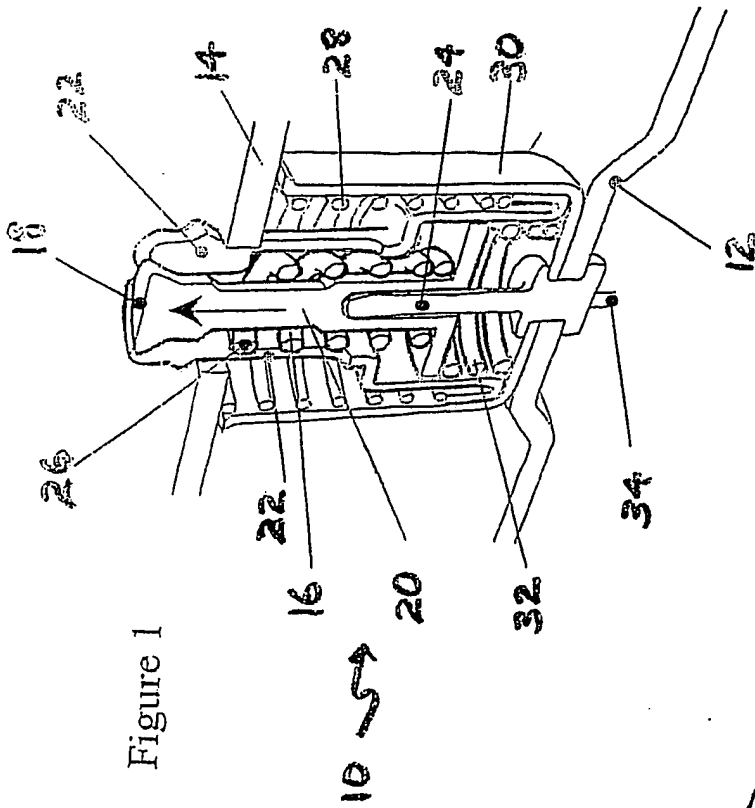


Figure 1

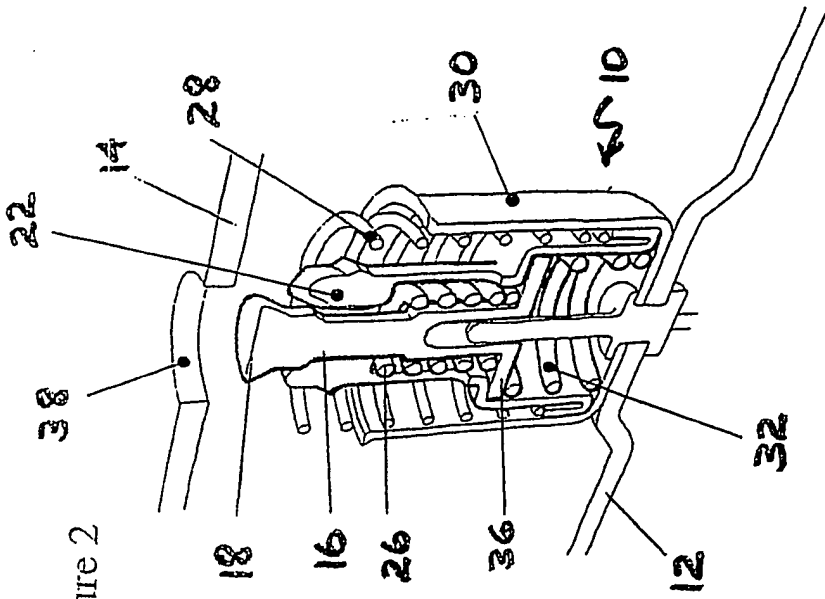


Figure 2

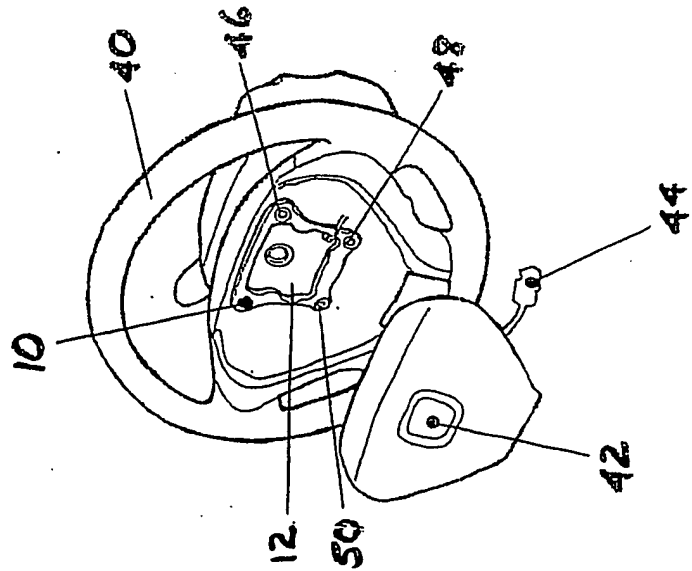


Figure 3

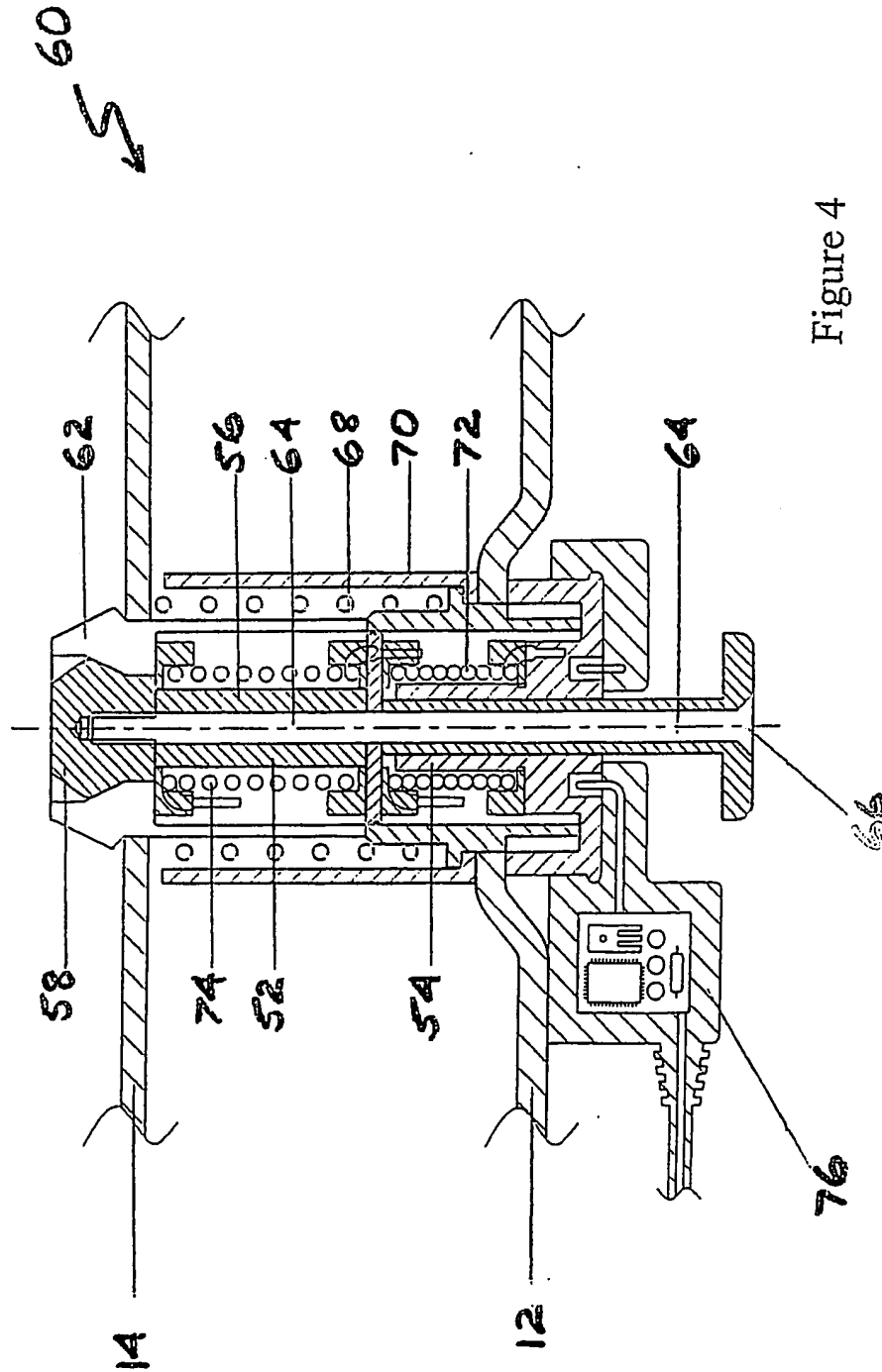


Figure 4

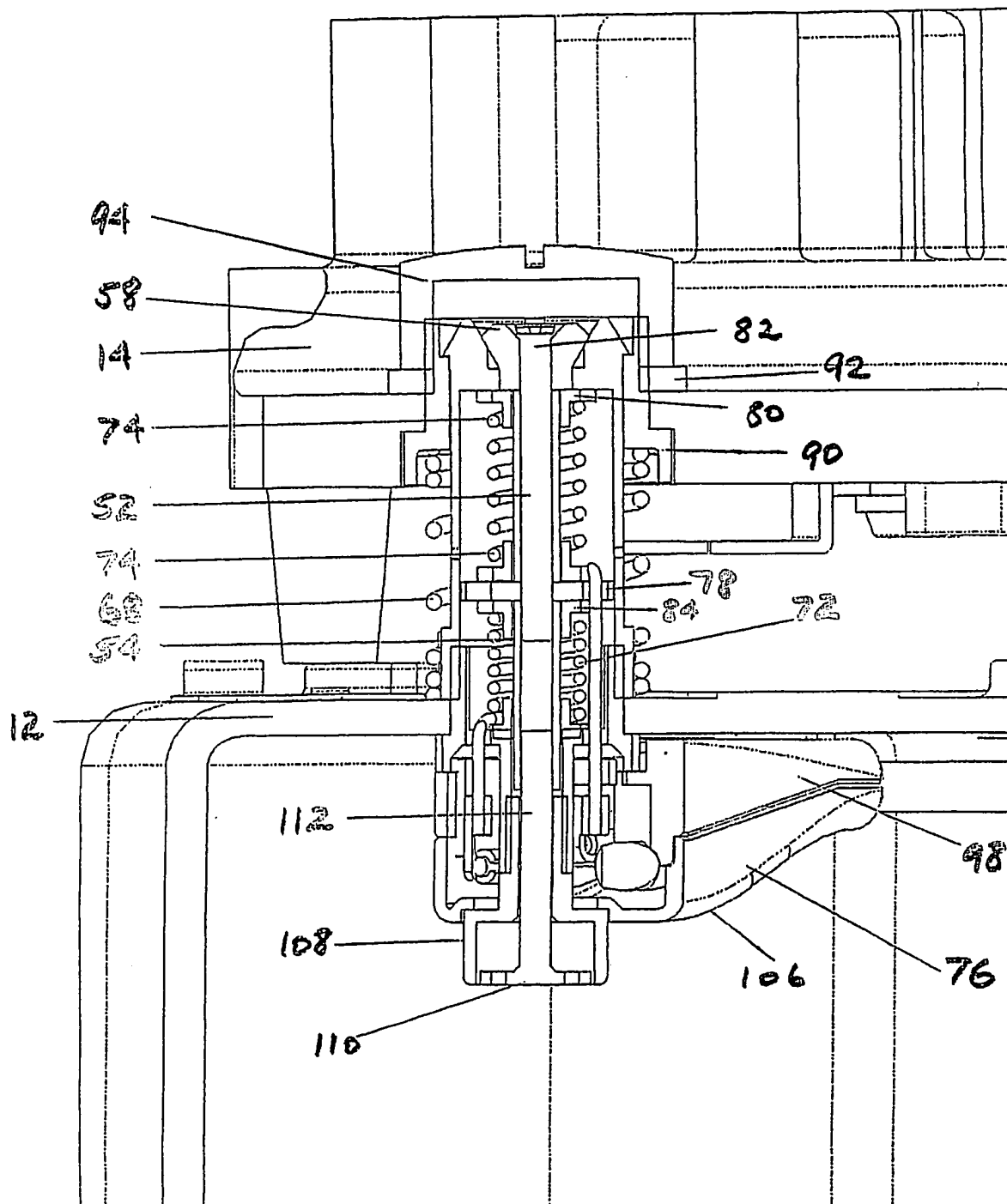


Figure 5

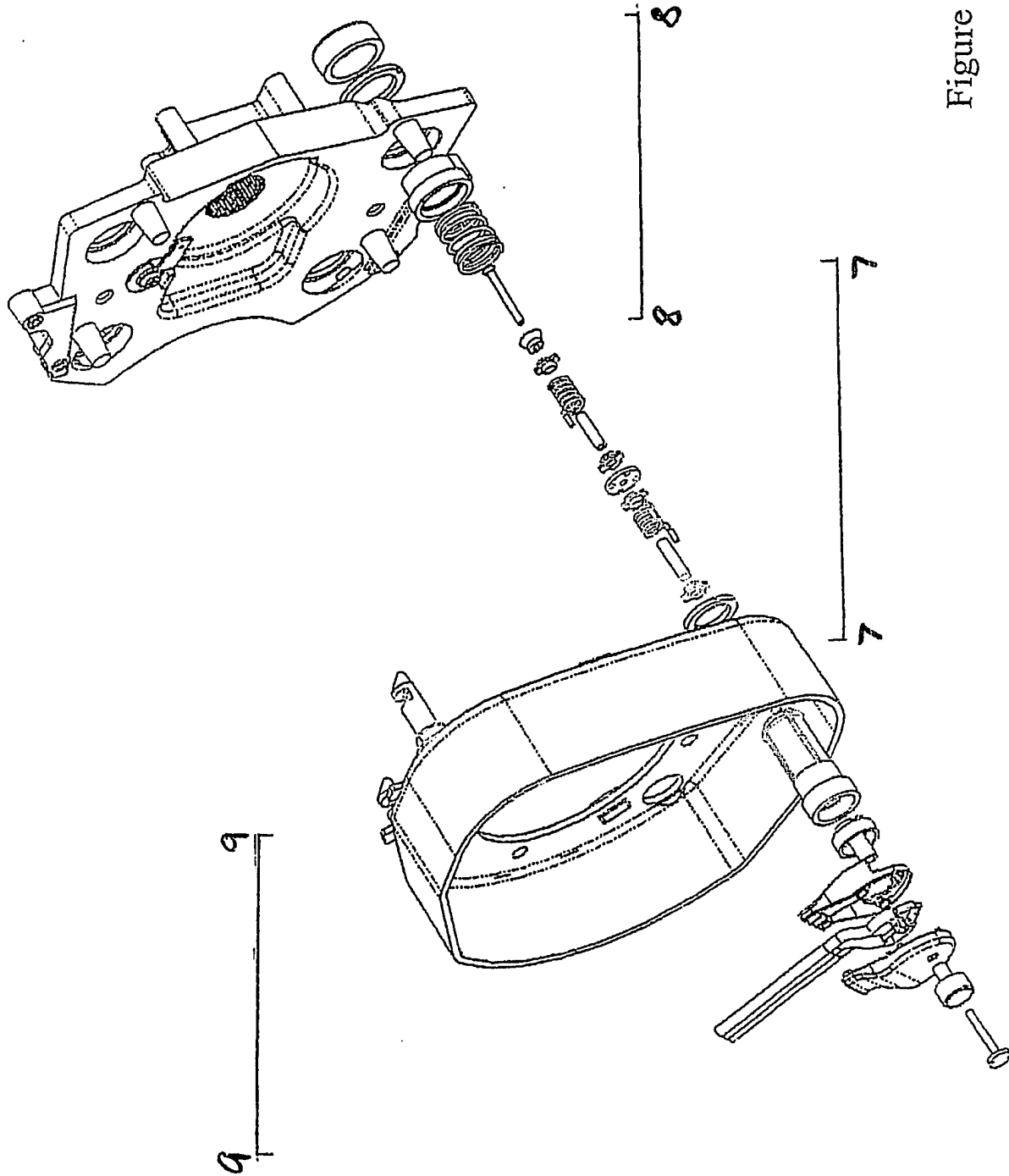


Figure 6

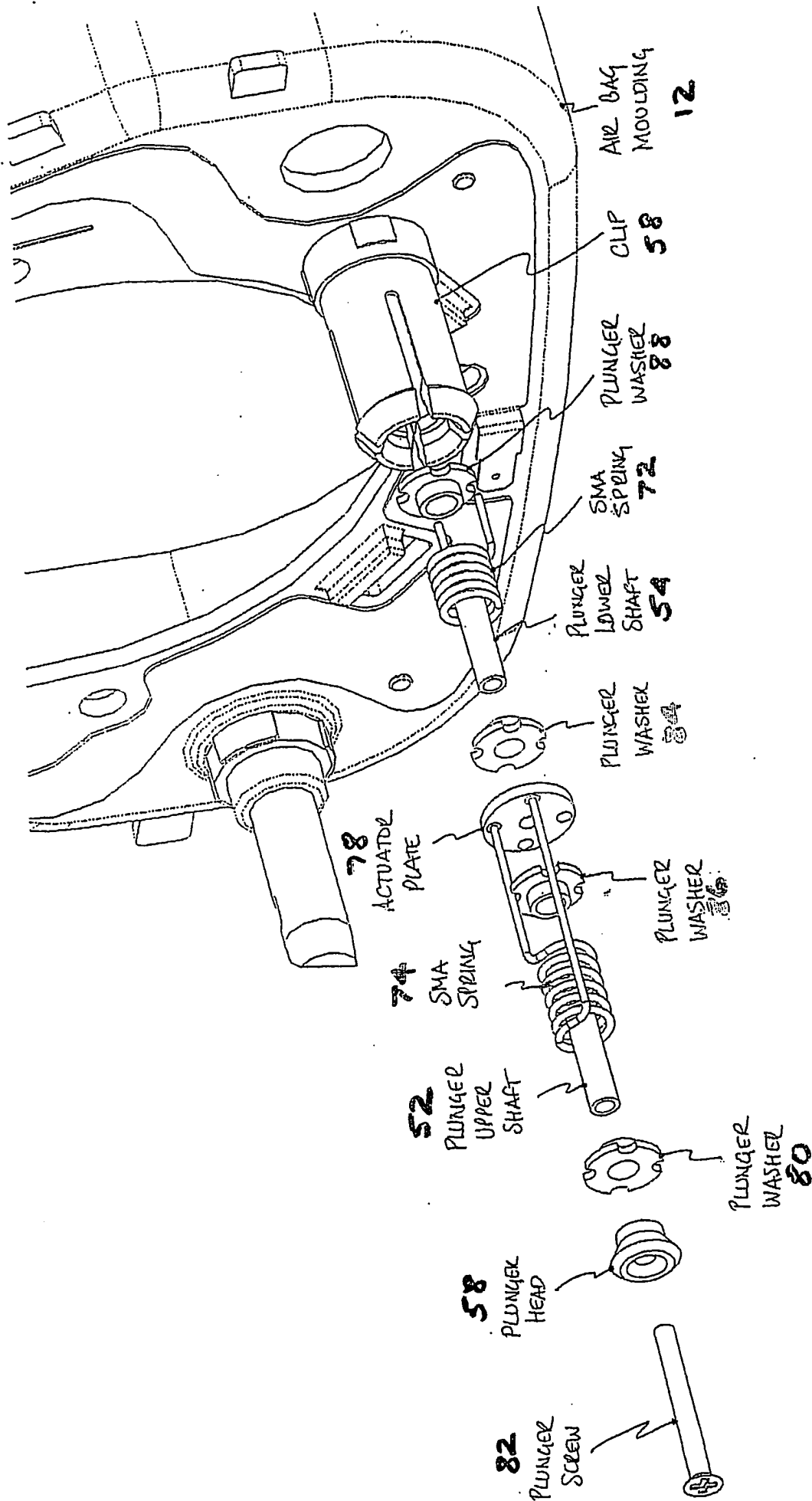


Figure 7

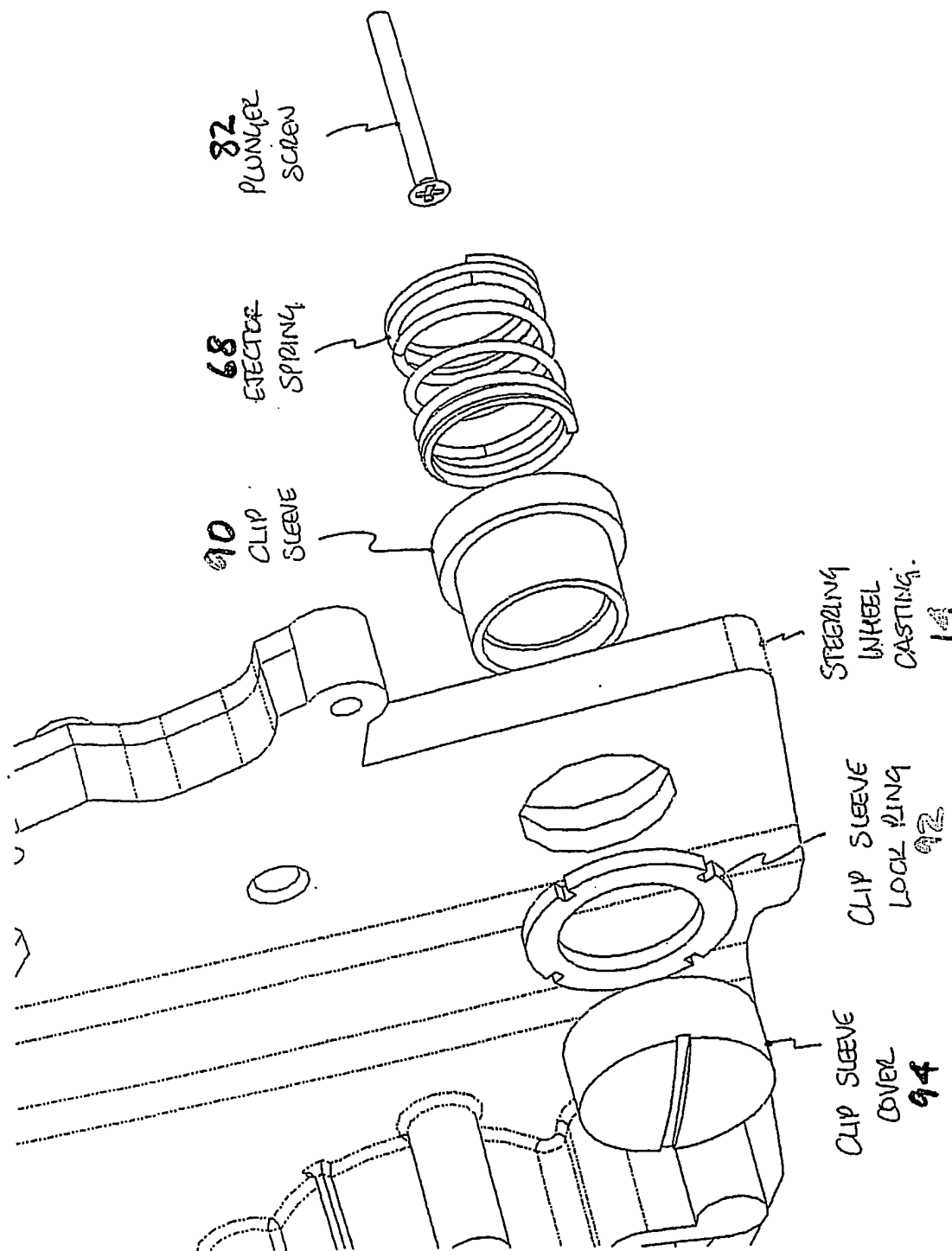


Figure 8

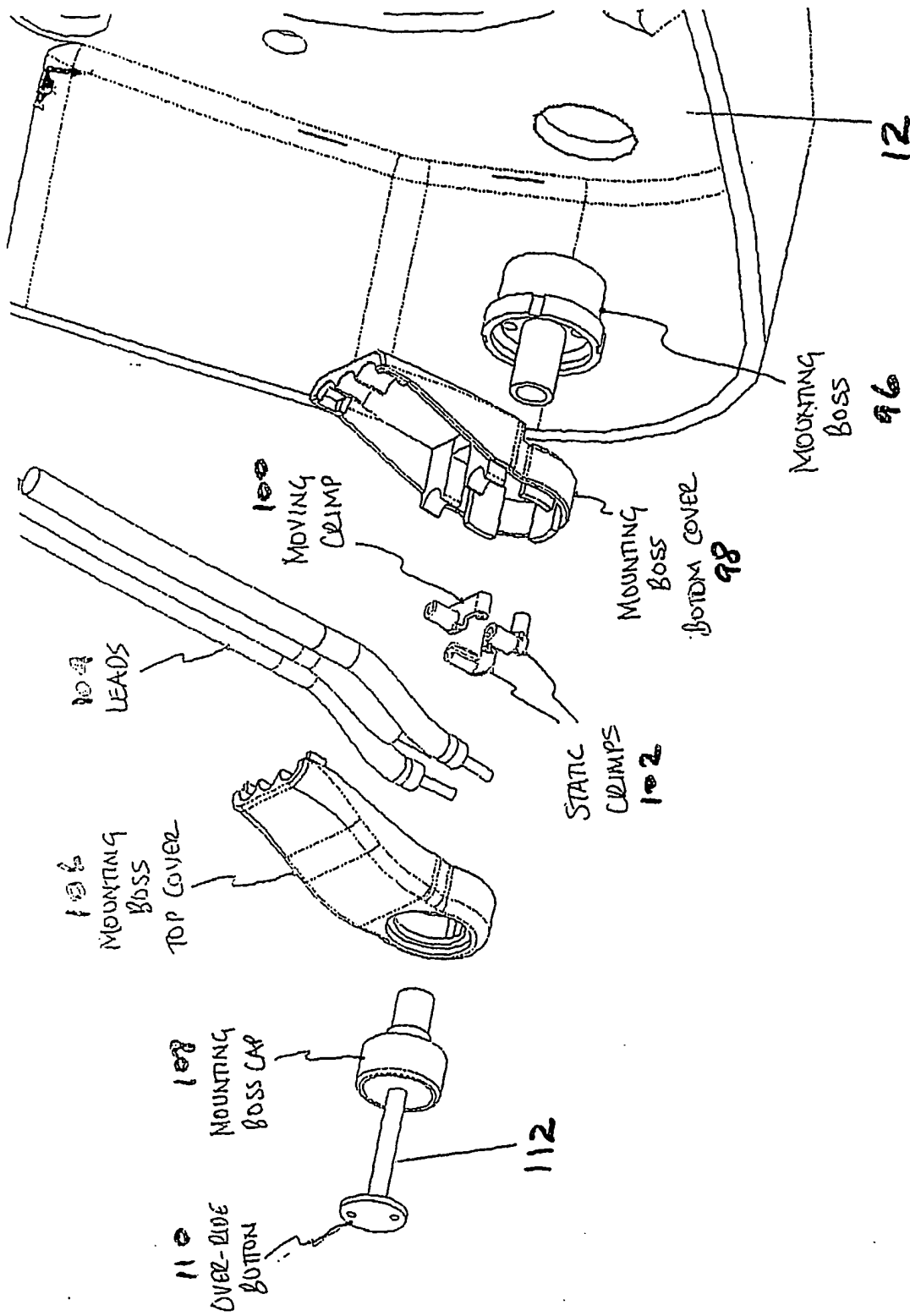


Figure 9



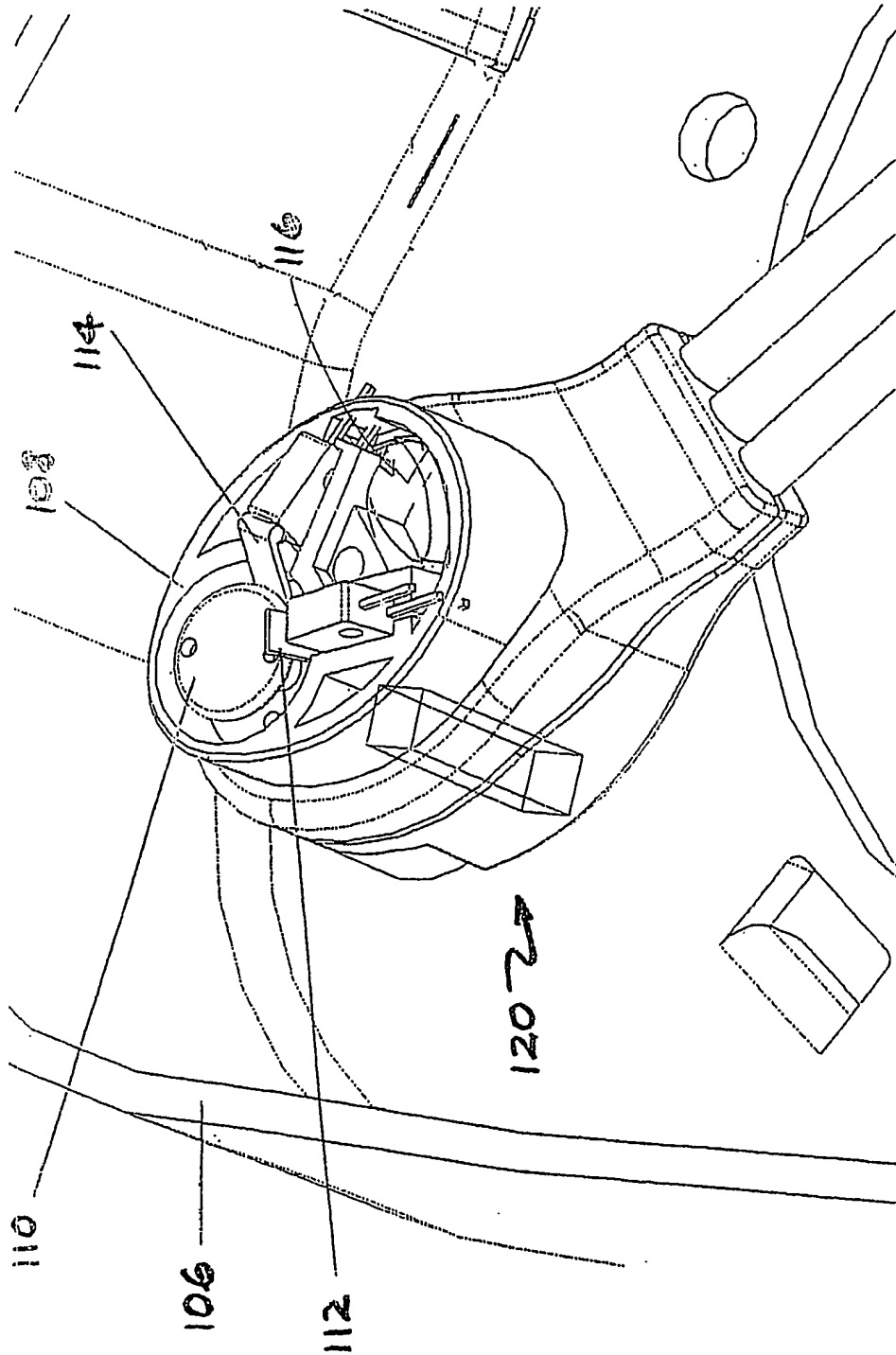


Figure 10

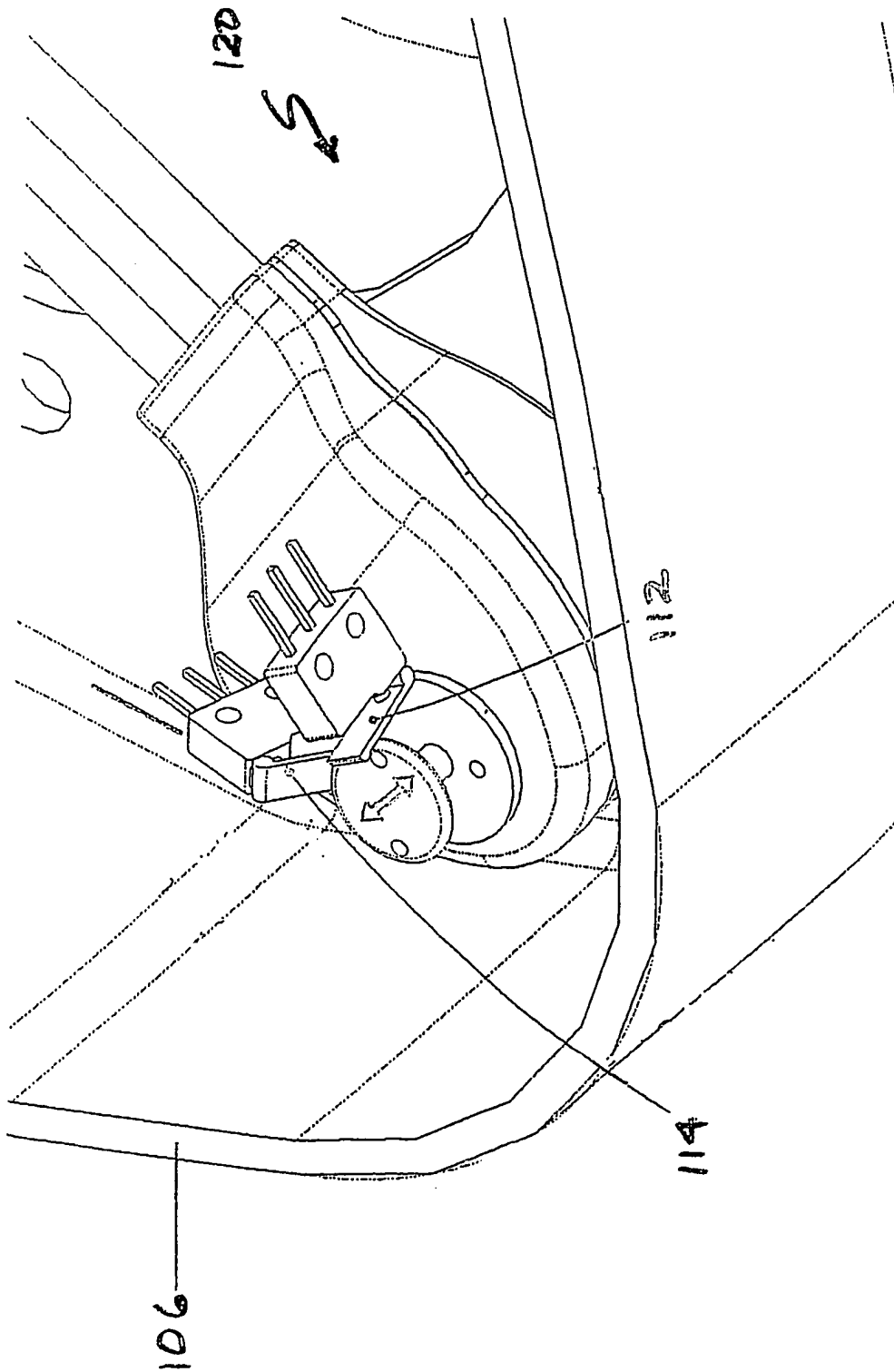


Figure 11

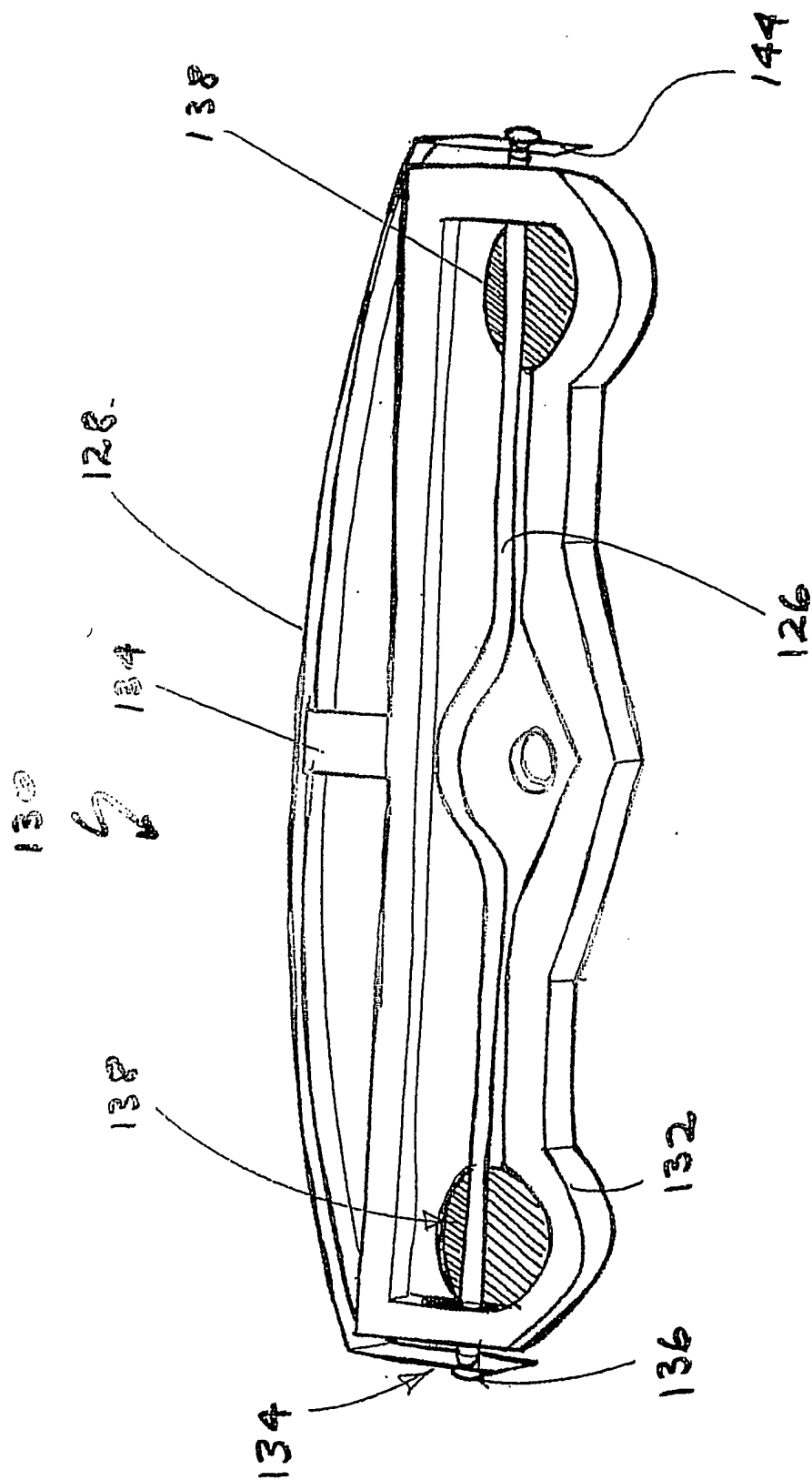


Figure 12

Figure 13

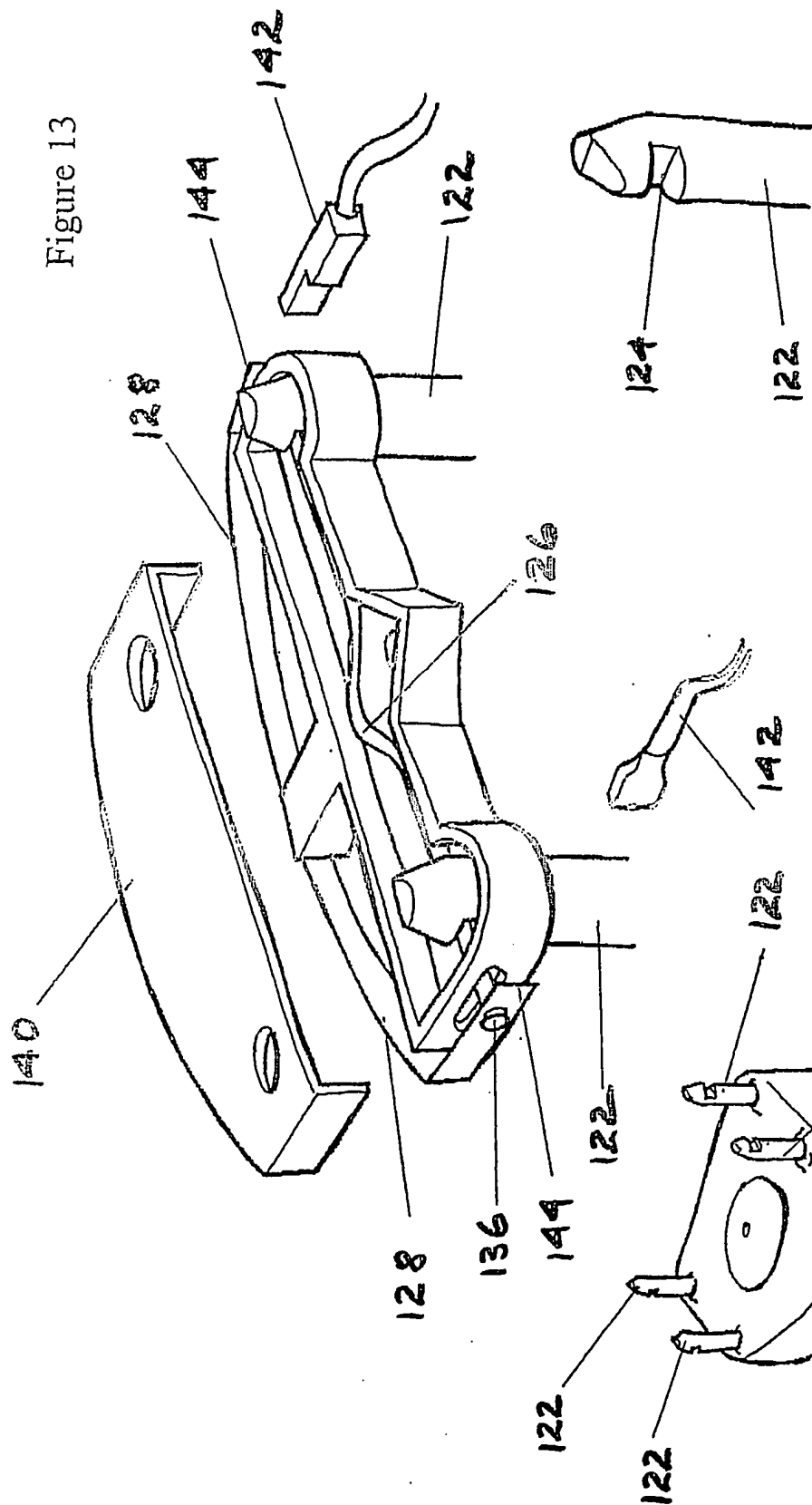


Figure 14

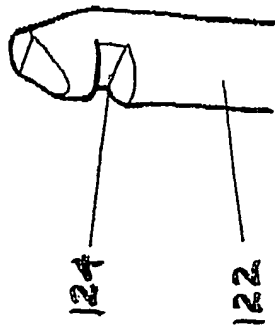
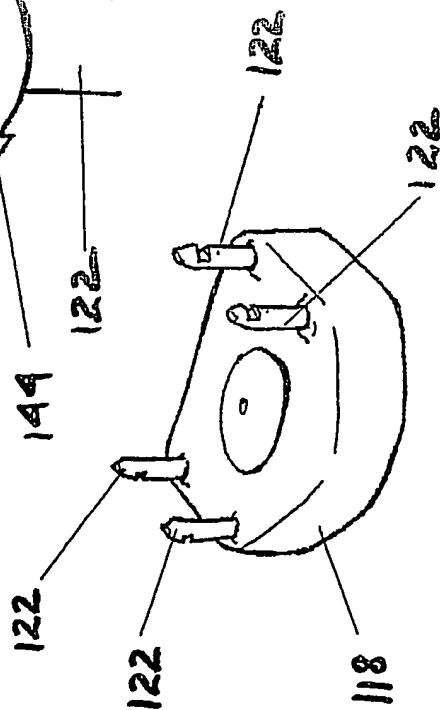
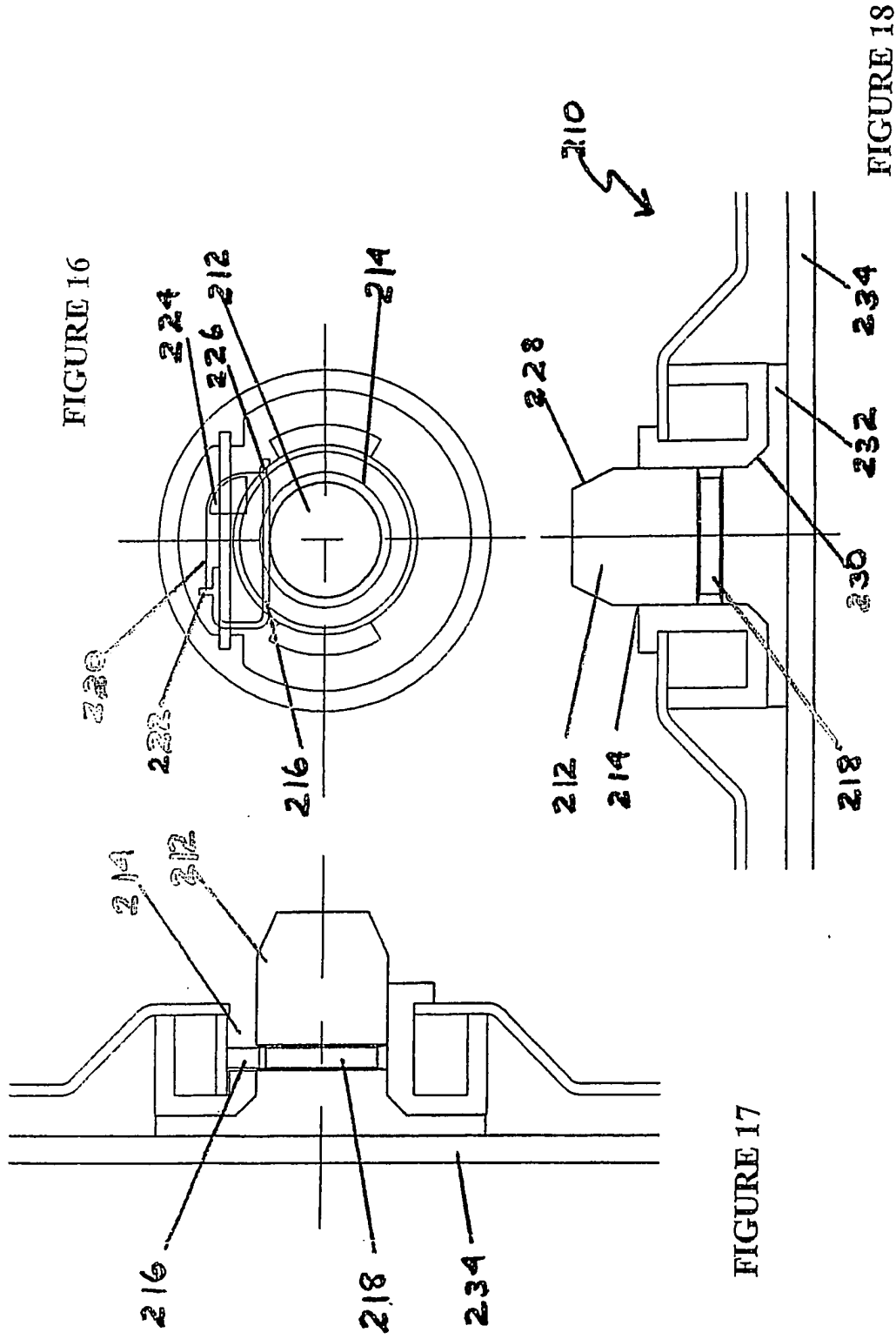


Figure 15





## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2004/000371

A. CLASSIFICATION OF SUBJECT MATTER		
Int. Cl. <sup>7</sup> : F16B 1/00, 21/06, 21/16, B60R 21/16, B64G 1/64		
According to International Patent Classification (IPC) or to both national classification and IPC.		
B. FIELDS SEARCHED		
Minimum documentation searched (classification system followed by classification symbols) Refer electronic database consulted below		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DWPI - IPC: F16B, B60R 21/-, B64G 1/- and keywords shape memory		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6508437 B1 (DAVIS et al) 21 January 2003 Whole document	1-5, 11-21, 24-31, 41-46, 52-63, 66-74 75-76
Y	US 6126115 A (CARRIER et al) 3 October 2000 Whole document	1-5, 7-31, 41-46, 48-74
X	GB 2166185 A (STC PLC(UNITED KINGDOM)) 30 April 1986 Whole document	32, 36-40 33-35
Y	US 6276711 B1 (KURZ et al) 21 August 2001 Whole document	33-35, 75-76
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input checked="" type="checkbox"/> See patent family annex		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 20 May 2004		Date of mailing of the international search report 27 MAY 2004
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustalia.gov.au Facsimile No. (02) 6285 3929		Authorized officer R. SUBBARAYAN  Telephone No : (02) 62832377

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2004/000371

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5380037 A (WORRELL et al) 10 January 1995	
A	US 5160233 A (MCKINNIS) 3 November 1992	
A	EP 1179457 A1 (AUTOLIV-ISODELTA) 13 February 2002	

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/AU2004/000371

**Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)**

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. ☐ Claims Nos.:  
because they relate to subject matter not required to be searched by this Authority, namely:
2. ☐ Claims Nos.:  
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:
3. ☐ Claims Nos.:  
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

**Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)**

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claims 1-31 & 41-78 are directed to a fastener including a locking pin movable between locked and release positions, and an actuator of shape memory alloy which is adapted when elongated to cause the pin to move to the release position. It is considered that the actuator of shape memory alloy which is adapted when elongated to cause the pin to move to the release position comprises a first "special technical feature".
2. Claims 32-40 are directed to a fastener assembly including a bar adapted to engage in a groove in a pin and a connecting means of shape memory alloy which is adapted to change shape and draw the bar out of engagement with the groove. It is considered that the connecting means of shape memory alloy which is adapted to change shape and draw the bar out of engagement with the groove comprises a second special technical feature.

Since the abovementioned groups of claims do not share any of the technical features identified, a "technical relationship" between the inventions, as defined in PCT rule 13.2 does not exist. Accordingly the international application does not relate to one invention or to a single inventive concept, a priori.

1. ☒ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. ☐ As all searchable claims could be searched without effort justifying an additional fee, this Authority did not invite payment of any additional fee.
3. ☐ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:
4. ☐ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest ☐ The additional search fees were accompanied by the applicant's protest.

☒ No protest accompanied the payment of additional search fees.



# INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU 2004/000371

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member			
US	6508437	WO	03059741		
US	6126115				
GB	2166185	AU	48519/85		
US	6276711	AU	32812/01	EP	1268240 WO 0172558
US	5380037				
US	5160233				
EP	1179457	FR	2812606	JP	2002087284
Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.					
END OF ANNEX					